

**Effective Span of Command and Control by Echelon in  
Training and Operational Environments**

**J. Patrick Ford**  
HumRRO

**William J. Mullen III**  
BDM Federal, Inc.

**Richard E. Christ**  
U.S. Army Research Institute

**Armored Forces Research Unit**  
**Barbara A. Black, Chief**

October 1998



DTIC QUALITY INSPECTED 2

19981027 063

**U.S. Army Research Institute  
for the Behavioral and Social Sciences**

Approved for public release; distribution is unlimited.

**U.S. Army Research Institute  
for the Behavioral and Social Sciences**

**A Directorate of the U.S. Total Army Personnel Command**

**EDGAR M. JOHNSON  
Director**

---

Research accomplished under contract  
for the Department of the Army

HumRRO  
BDM Federal, Inc.

Technical review by

Robert E. Solick

**NOTICES**

**DISTRIBUTION:** This Research Note has been cleared for release to the Defense Technical Information Center (DTIC) to comply with regulatory requirements. It has been given no primary distribution other than to DTIC and will be available only through DTIC or the National Technical Information Service (NTIS).

**FINAL DISPOSITION:** This Research Note may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

**NOTE:** The views, opinions, and findings in this Research Note are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other authorized documents.

## REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy) October 1998	2. REPORT TYPE Final	3. DATES COVERED (from. . . to) July 1993 – October 1995					
4. TITLE AND SUBTITLE  Effective Span of Command and Control by Echelon in Training and Operational Environments		5a. CONTRACT OR GRANT NUMBER MDA903-92-D-0075-0010					
		5b. PROGRAM ELEMENT NUMBER 0603007					
6. AUTHOR(S)  J. Patrick Ford (HumRRO); William J. Mullen III (BDM Federal); and Richard E. Christ (ARI)		5c. PROJECT NUMBER A793					
		5d. TASK NUMBER 1122					
		5e. WORK UNIT NUMBER C05					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  Human Resources Research Organization (HumRRO) 66 Canal Center Plaza Suite 400 Alexandria, VA 22314		8. PERFORMING ORGANIZATION REPORT NUMBER					
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)  U.S. Army Research Institute for the Behavioral and Social Sciences ATTN: TAPC-ARI-IK 5001 Eisenhower Avenue Alexandria, VA 22333-5600		10. MONITOR ACRONYM ARI					
		11. MONITOR REPORT NUMBER Research Note 99-03					
12. DISTRIBUTION/AVAILABILITY STATEMENT  Approved for public release; distribution is unlimited.							
13. SUPPLEMENTARY NOTES   COR: Richard E. Christ. This Final Report presents a description and discussion of the indicated research effort. See the companion Interim Report by the same authors (in preparation), New Research on Span of Command							
14. ABSTRACT (Maximum 200 words):  In response to reduced resources in the face of more diverse missions, Army leadership is considering new options for the design of its organizations. One option is to create 'flatter' organizations. A consequence of this option is an increase in the span of command and control, and a concern with its impact on the effectiveness of command and control. This report summarizes research conducted to develop a database of information pertaining to seven factors proposed to influence the span of effective command and control, and guidelines for designing and training units that maintain effective spans of command and control. Fifty-five Army officers at various echelons and from different types of units participated in interviews. The resulting database is a set of comments and ratings about the relation between each of the seven factors and the difficulty (or ease) of command and control. The research confirmed the usefulness of the seven factors for discussing issues impacting span of effective command and control. The data were consolidated into observations that pertain to organizing and training military units. This report: (a) presents the results of this research, (b) recommends modifications to the data collection procedures, and (c) proposes further applications of the approach.							
15. SUBJECT TERMS  Organizational Design      Span of Control      Span of Command and Control							
16. REPORT Unclassified			17. ABSTRACT Unclassified	18. THIS PAGE Unclassified	19. LIMITATION OF ABSTRACT Unlimited	20. NUMBER OF PAGES 30	21. RESPONSIBLE PERSON (Name and Telephone Number) Richard E. Christ 254-286-6946

**Research Note**

**EFFECTIVE SPAN OF COMMAND AND CONTROL  
BY ECHELON  
IN TRAINING AND OPERATIONAL ENVIRONMENTS**

**J. Patrick Ford**  
HumRRO

**William J. Mullen III**  
BDM Federal, Inc

**Richard E. Christ**  
U.S. Army Research Institute

**Armored Forces Research Unit**  
**Barbara A. Black, Chief**

U.S. Army Research Institute for the Behavioral and Social Sciences  
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

**October 1998**

---

Army Project Number  
20363007A793

Training Systems and Education

Approved for public release; distribution is unlimited

# EFFECTIVE SPAN OF COMMAND AND CONTROL BY ECHELON IN TRAINING AND OPERATIONAL ENVIRONMENTS

## CONTENTS

---

	Page
INTRODUCTION .....	1
Background.....	1
Factors Affecting Span of Command and Control .....	1
Project Objectives .....	3
APPROACH .....	4
Development of Interview Protocol.....	4
Internal tryouts .....	4
Pilot tryout of individual approach .....	5
Adaptation for group approach.....	5
Sample of Officers Interviewed.....	6
Force projection and OOTW .....	6
Warfighting operations .....	7
Interview Procedures .....	9
Force projection and OOTW .....	9
Warfighting operations .....	10
RESULTS .....	10
Comments Related to JTFs in Force Projection and OOTW Missions .....	11
Ratings of the Impact of Factors on Command and Control in Warfighting	
Operations.....	13
Comments Related to Army Units in Warfighting Operations.....	15
GENERAL DISCUSSION .....	21
Modifications to Procedure.....	21
Further Applications of Procedure.....	22
Increase the database.....	22
Add other echelons to the force projection and OOTW database .....	22
Develop support materials for OOTW .....	22
Expand database on warfighting operations with CTC experience.....	22
Develop a database on the Experimental Force .....	22
CONCLUSIONS .....	23
REFERENCES .....	25

CONTENTS (continued)

---

	Page
<b>LIST OF TABLES</b>	
Table 1. Factors Affecting Span of Effective Command and Control.....	3
2. Duty Position by Operation for Interviews Concerning Force Projection and OOTW.....	7
3. Duty Position by Unit for Interviews Concerning Warfighting Operations .....	8
4. Environment by Echelon for Missions Addressed in Interviews on Warfighting Operations .....	9
5. Overview of Recommendations on Forming JTFs from Interviews on Force Projection and OOTW Missions.....	11
6. Mean Overall Impact of Factors .....	14
7. Mean Impact Rating by Echelon.....	14
8. Mean Impact Rating by Unit Type, Across Echelons.....	15
9. Overview of Conclusions Related to Impact of Factors on Warfighting Operations .....	16

## EFFECTIVE SPAN OF COMMAND AND CONTROL BY ECHELON IN TRAINING AND OPERATIONAL ENVIRONMENTS

### INTRODUCTION

#### Background

Field Manual (FM) 100-5, Operations (Department of the Army [DA], June 1993) sets the requirement for units to be effective not only in their core combat missions, but also in force projection missions, such as JUST CAUSE (Panama), and in operations other than war (OOTW), such as support to civilian authorities following Hurricane Andrew. At the same time that the number of potential missions and the degree of variation in the possible operational environment are expanding, the amount of resources to support the missions is shrinking. Consequently, there are fewer soldiers for more complicated and more diverse missions.

In response to the reduced resources in the face of the more diverse missions, Army leadership is reorganizing resources, soldiers, equipment, and facilities. One option in the reorganization is to create a "flatter" organization by eliminating layers of command. Since the flatter organization increases the number of subordinate units a commander commands and controls, questions arise about the number of units a commander can command and control effectively (the span of effective command and control). Factors other than organizational design also promise to affect the span of effective command and control. For example, Army leaders are incorporating high technology decision support systems. Such enhancements of a commander's ability to monitor accurately the status of subordinate units should increase the potential range of the commander's capability to monitor and influence actions and, hence, increase the span of effective command and control.

The Army Research Institute (ARI) identified the need to develop a database of factors that influence the size of a commander's span of effective command and control. The Combined Arms Command, Force Design Directorate (CAC-FDD) was the proponent for a project to develop the framework and initial information for such a database. While the initial focus was on core combat missions, the scope was soon expanded to include force projection and OOTW missions, which provided an opportunity to study command and control in a joint task force (JTF). The data collection approach considered the information processing workload imposed in military operations and the factors that affected that workload. This report describes the approach for collecting information on the relation of those factors to the information processing workload and implications of the information for designing units and organizing JTFs.

#### Factors Affecting Span of Command and Control

The information processing workload imposed for command and control in some environments could stretch the ability of commanders and, over time, make them less than fully effective. In classical management theory, the pivotal factor affecting this workload is the number of subordinate units assigned to the commander. In general, the information processing workload imposed by command and control tasks (or more simply, command and control

workload) increases as a direct function of the number of subordinate units. Thus, the command and control of large numbers of subordinate units could affect a commander's performance adversely, especially when the number of units increases the "friction" of combat -- defined in FM 100-5 as "accumulation of chance errors, unexpected difficulties, and confusion" (DA, June 1993). Such friction can wear down the energy and reduce the problem-solving skill of even the most capable commanders.

At the same time, a large number of subordinate units potentially offers some benefits, such as more sources of information, more resources to help with a mission, and (if intermediate levels are reduced) more direct communication. Therefore, force designers are interested in determining the largest number of subordinate units that a commander can effectively manage without being overloaded.

In the 1950s, there was interest in identifying the optimal number of employees that a supervisor could manage (Wenzel & Christ, 1993). Some researchers saw an analogy between span of command and control and work in the mid-1950s on the span of attention, i.e., the number of objects that a human can consciously perceive. In a classic paper, Miller (1956) speculated that attention span and other related phenomena represented a basic limitation in human information processing. The capacity was estimated at about seven units, plus or minus two units. The literature on group dynamics generally supported the more conservative estimate: Based on research performed in the 1950s, Koontz, O'Donnell, and Weihrich (1984) concluded that groups comprising five members were rated highest in cohesion and inferred to be the most effective. Speculating that this finding reflected some basic information processing limitation, management consultants have recommended that managers supervise no more than five subordinates or subordinate units in a hierarchical structure.

One problem with the above "rule of five" is that it is based on outmoded concepts of information processing. Research from the late 1970s indicates that the severe information processing limitations that were once thought immutable can be effectively circumvented under certain conditions (e.g., Mintzberg, 1983; Schneider & Shiffrin, 1977; and Wickens, 1980). Such conditions include increased standardization, similarity of tasks, and an organizational structure that facilitates clear communication. From an information processing perspective, the commander's capacity is a limited resource that is affected by a range of factors in addition to the number of subordinate units. These factors have an impact on the span of command and control by either increasing or decreasing command and control workload. Even though many factors can affect command and control workload, Wenzel and Christ (1993) have argued that there are a limited number of related factors that can, in principle, be controlled through the systematic design and development of Army organizations. The methodology described in this report is adapted from their model and proposes seven factors that determine span of effective command and control. The factors are listed in Table 1.

Table 1

## Factors Affecting Span of Effective Command and Control

Factor	Elements
Task Characteristics	<ul style="list-style-type: none"> <li>• Tasks on Mission Essential Task List (METL)</li> <li>• Extent units had to coordinate with each other</li> <li>• Amount of specialized knowledge required by tasks</li> </ul>
Organizational Structure	<ul style="list-style-type: none"> <li>• Number of units controlled</li> <li>• Type of units</li> <li>• Composition of units</li> <li>• Structure of staff</li> </ul>
Complexity of Environment	<ul style="list-style-type: none"> <li>• METT-T<sup>a</sup> factors</li> <li>• Ambiguities</li> <li>• Constraints</li> </ul>
Unit Continuity	<ul style="list-style-type: none"> <li>• Extent of members' experience with organizational structure</li> <li>• Extent of members' experience with unit Standard Operating Procedures (SOP)</li> <li>• Shared experience among leaders and staff</li> <li>• Experience with similar missions</li> </ul>
Technology	<ul style="list-style-type: none"> <li>• Communication equipment</li> <li>• Tactical command and control systems</li> </ul>
Individual Characteristics	<ul style="list-style-type: none"> <li>• Commander's training and experience</li> <li>• Training and experience of subordinate leaders</li> <li>• Quality of staff</li> <li>• Leader traits of commander and subordinates</li> </ul>
External Organizations	<ul style="list-style-type: none"> <li>• Military commands outside normal Army channels (e.g., Headquarters [HQs] of joint and allied forces)</li> <li>• Government organizations such as civilian government officials (e.g., mayors) and agencies (e.g., Federal Emergency Management Administration [FEMA])</li> <li>• Non-government organizations (NGOs), United States (U.S.) (e.g., American Red Cross) and foreign (e.g., Red Crescent)</li> </ul>

<sup>a</sup> Mission, Enemy, Terrain, Troops available - Time

### Project Objectives

A variety of approaches is available to solve problems related to the span of effective command and control. As with most human performance problems, possible solutions include

selection, training, and human factors design. The selection approach is to identify and promote leaders who have high ability to process information and monitor a wide range of subordinates. The training approach emphasizes enhancing skills for processing information. The human factors design approach structures the job to accommodate typical limitations related to the command and control factors and anticipates alternatives for task organization.

A full program of research related to the span of command and control would consider all three approaches. Each approach requires a detailed analysis of the impact that span of command and control has on military operations. Such an analysis should include a wide range of specific examples where the span influences the effectiveness of Army units at echelons from platoon through corps. This project was designed to provide the framework of information for that analysis and present guidelines related to the human factors design approach.

The objectives of this project were:

- To develop a database of information pertaining to factors that influence the effectiveness of the span of command and control.
- To develop guidelines for designing units that maintain effective spans of command and control.

## APPROACH

The approach to meet the objectives was to conduct interviews of officers at various echelons concerning the command and control requirements in a specific operation, then extract conclusions related to the command and control factors from the interview comments. This section describes the development of the interview protocol, the sample of officers who were interviewed, and the interview procedures.

### Development of Interview Protocol

The interview protocol was developed in three stages: Internal tryouts of individual approach, pilot tryout of individual approach, and adaptation for group approach.

Internal tryouts. The initial protocol was based on the critical decision method as described by Klein, Calderwood, and MacGregor (1989), which in turn is a modification of the critical incident techniques (Flanagan, 1954). Interviewers gave the officer an overview of the factors given in Table 1. Then, the interviewer asked the officer to select incidents from a mission in which he had personally participated and to describe the relation of the command and control factors to those incidents. This approach was tried out with internal (or in-house) interviews with a member of the Project staff, Brigadier General (retired) Mullen, on port operations he commanded during DESERT SHIELD/STORM. As a result of those tryouts:

- The scope was modified to orient on command and control requirements within the overall mission (rather than incidents within the mission).

- Greater detail on the factors was developed -- relevant elements were added to the list of factors affecting span of command and control.
- Interviewees were asked to diagram their organizational structure.
- Interviewees were asked to rate the difficulty of command and control.

Project staff summarized the results of the internal tryout by factor (Ford & Mullen, 1994). That summary and the list of factors with descriptive elements were used as read-ahead materials for the participants of all subsequent interviews.

Pilot tryout of individual approach. Project staff conducted a pilot tryout of the protocol for individual interviews with a General Officer who had about 10 years earlier, as a Lieutenant Colonel, commanded a battalion task force (TF) for peacekeeping operations in the Sinai. The pilot tryout confirmed the appropriateness of orienting on critical personal experiences of the interviewee in a mission in which he had been a participant. The pilot tryout also illuminated the need to further clarify the scope of the factors that influence span of command and control for military operations:

- Ambiguity was added as an element to the factor of Complexity of Environment.
- The factor formerly called "History" was renamed and changed to Unit Continuity.

The major observation from the pilot tryout was the obvious enthusiasm by the officer interviewed to describe the command and control challenges he faced. This cooperation was the pattern throughout the data collection, and was pivotal in securing support of subsequent officers.

Adaptation for group approach. Project staff revised the protocol before the start of data collection on war-fighting operations. The purpose of the revision was to make the approach suitable for group interviews. Units could not be expected to support the amount of time required if only individual interviews were used. Furthermore, the Project staff wanted to minimize their disruption of unit activities. The adaptations were designed to increase the structure of the interview process through the following three modifications to the earlier approach:

- Diagrams of potential command structures were developed for each position. Each commander then modified a diagram appropriate to the position he held during the mission of interest (rather than developing his own diagram).
- Each commander made direct ratings of the impact of each factor on command and control in the mission on a rating form. The rating scale had seven points from Much Easier through No Impact to Much Harder.

- Each commander rated the success and the difficulty of the mission. The scale for success ran from 1 (Unsuccessful) to 5 (Completely Successful). The scale for difficulty ran from 1 (Low Workload) to 10 (High Workload).

### Sample of Officers Interviewed

As noted earlier, the scope of the data collection was expanded early in the planning stages to include force projection operations and OOTW. This expansion of scope was largely in response to a need by CAC-FDD for insights on options to form a JTF. The immediate concern was whether a JTF should be based on an intact organization or formed on an *ad hoc* basis from separate organizations to incorporate diverse capabilities. Because of the need for a quick response on JTFs, the force projection operations and OOTW were addressed before the warfighting operations. The sample for each phase is described below.

Force projection and OOTW. Three operations were chosen (based on their recency, complexity, and diversity) to provide the core of missions to be studied:

- Operations in Panama. The initial interest was the force projection operation JUST CAUSE, with emphasis on how a division was integrated into a corps. As the interviews were conducted, the scope was expanded to include operations preceding the force projection phase (SAND FLEA) and operations following the force projection phase (PROMOTE LIBERTY).
- Peacekeeping in Somalia (RESTORE HOPE). This operation was chosen to give insight in two areas: Division serving as Army Force (ARFOR) and the role of an Army unit in a JTF commanded by a sister service (in this case, Marine Corps).
- Disaster relief following Hurricane Andrew (PROVIDE RELIEF). This operation was chosen to provide insights on domestic operations and to illuminate considerations in having a Continental U.S. Army (CONUSA) provide the Headquarters (HQ) structure.

Other operations were added as opportunities to collect information presented themselves: Peacekeeping in Sinai was the focus for a pilot of the interview protocol, and the interview on riot response in Los Angeles developed as a result of comments made during an interview on warfighting operations.

The only constraints for selecting officers to be interviewed were that they had to be active duty Army officers assigned in the continental United States. The sponsor could not ensure access to Reserve officers, retirees, or members of other services; contract resources could not support foreign travel. While the emphasis in all operations was on the commander (CDR), special efforts were made to identify staff officers for Operation PROVIDE RELIEF.

The project sponsor initiated contact with potential officers in the core operations. All officers who were asked to participate agreed to be interviewed. The final force projection/OOTW sample included 11 officers--10 of whom held the rank of Brigadier General

or higher at the time of the interview (the other was a Colonel). The duty positions of the interviewees at the time they participated in the operations of concern are shown by operation in Table 2.

Table 2

Duty Position by Operation for Interviews Concerning Force Projection and OOTW

Operation	Position during operation
Panama: SAND FLEA, JUST CAUSE, PROMOTE LIBERTY	<ul style="list-style-type: none"> <li>• Brigade Commander</li> <li>• Division Commander</li> <li>• Commander JTF-Panama (SAND FLEA) and Deputy Commander JTF-South (JUST CAUSE and PROMOTE LIBERTY)</li> <li>• Southern Command J3<sup>a</sup></li> </ul>
RESTORE HOPE (Somalia)	<ul style="list-style-type: none"> <li>• Army Force (ARFOR) Commander (Division Commander)</li> </ul>
Peacekeeping Force in Sinai	<ul style="list-style-type: none"> <li>• Battalion Task Force Commander</li> </ul>
Support to Los Angeles Authorities (L.A. Riots Response)	<ul style="list-style-type: none"> <li>• JTF J3</li> </ul>
PROVIDE RELIEF (Hurricane Andrew)	<ul style="list-style-type: none"> <li>• Commander JTF-Army</li> <li>• Deputy Commander JTF-Army</li> <li>• Chief of Staff JTF-Army</li> <li>• J3 JTF-Army</li> </ul>

<sup>a</sup> Southern Command had overall responsibility for operations in Panama; J3 is the operations officer on the staff of the JTF.

Warfighting operations. The interviews related to warfighting operations included officers at echelons from company to corps. The interviews were conducted at three divisions: 2nd Armored Division, 1st Cavalry Division, and 82nd Airborne Division. These divisions were chosen because they were the most recent units to complete Warfighter Exercises in the Battle Command Training Program (BCTP) during the data collection time frame. In addition, members of the III Corps command group and the commander of the Corps Support Command (COSCOM) were interviewed. The positions of the interviewees during the warfighting mission of interest are summarized in Table 3.

The double entries in Table 3 represent multiple interviews for the position. In both cases, recently assigned officers did not have sufficient experience in their current positions to discuss span of command and control from the perspective of their new positions. They, therefore, focused on missions they conducted when they were brigade commanders.

Table 3

## Duty Position by Unit for Interviews Concerning Warfighting Operations

Position	III Corps	2nd Armor Division	1st Cavalry Division	82nd Air-borne Division
Corps Commander	X			
Corps Deputy Commander	X			
Corps Chief of Staff	X			
COSCOM Commander	X			
Division Commander		X	X	
Assistant Division CDR		X		X
Division Chief of Staff		X		X
Division G3 <sup>a</sup>		X		X
Division Deputy G3			X	
Brigade Commander		X X	X X	X
DIVARTY <sup>b</sup> Commander	X		X	X
DISCOM <sup>c</sup> Commander	X		X	X
Brigade S3 <sup>d</sup>	X		X	X
Battalion TF CDR	X		X	X
FA <sup>e</sup> Battalion CDR	X		X	X
FSB <sup>f</sup> CDR	X		X	X
Maneuver Company CDR			X	X
FA Battery CDR	X		X	X
Support Company CDR	X		X	X

<sup>a</sup> Assistant Chief of Staff, Operations and Plans (division or corps).

<sup>b</sup> Division Artillery; brigade-size element.

<sup>c</sup> Division Support Command; brigade-size element.

<sup>d</sup> Training and Operations Officer on a battalion or brigade staff.

<sup>e</sup> Field Artillery; battalion is subordinate to DIVARTY.

<sup>f</sup> Forward Support Battalion; battalion is subordinate to DISCOM.

To ensure relevant recent experience at the highest echelons, the interviews were scheduled to follow Warfighter Exercises in BCTP. Since echelons below brigade have limited roles in BCTP exercises, the missions covered in interviews of battalion and company commanders were predominately from rotations to the National Training Center (NTC) and the Joint Readiness Training Center (JRTC). Each officer was free to select a mission other than the

one that had been anticipated, and several officers took that option. The environments for warfighting operations are summarized by echelon in Table 4. For summarizing the sample and results, the COSCOM Commander was considered to be at the Division echelon. The COSCOM Commander is a General Officer of a major component of the Corps and reports directly to the Corps Commander.

Table 4

Environment by Echelon for Missions Addressed in Interviews on Warfighting Operations

Echelon	BCTP	NTC	JRTC	DESERT STORM	Other	Total
Corps	3	0	0	0	0	3
Division	9	0	0	0	1	10
Brigade	9	3	1	1	0	14
Battalion	1	4	3	1	0	9
Company	1	4	3	0	0	8
Total	23	11	7	2	1	44

Interview Procedures

The data collection process consisted of two parts:

- Force Projection and OOTW, conducted first to provide quick-response information to the sponsor.
- Warfighting Operations.

In both parts, the interview team included a retired general officer and two behavioral scientists.

Force projection and OOTW. The first series of interviews encouraged a wide range of discussion related to command and control with limited direct focus on the factors related to the span of command and control. Each commander began by diagramming the command structure for the operation. The diagram included each element of his higher command, units within his span of command and control, and other units or organizations with whom he coordinated. The commander then described events during the operation that illustrated the effect of the factors on the difficulty of commanding and controlling the subordinate units. The commander next rated the difficulty of the operation and discussed types of changes that would have helped him command and control his subordinates more effectively.

With one exception, officers were interviewed individually. In the one exception, two officers (the PROVIDE RELIEF commander and deputy commander) were interviewed together in one session. While the framework for the interviews was structured by factor, most of the interviews were relatively free-ranging discussions of the mission, oriented largely toward lessons learned regarding organizing a joint task force (JTF). The interviews covering Los Angeles Riots and the first three positions listed in Table 2 for PROVIDE RELIEF were conducted with the more structured protocol.

Warfighting operations. At the beginning of the phase related to warfighting operations, it became clear that the units could not support the amount of time required by the individual interviews. At the same time, the interviewers sought ways to increase focus on the impact of the factors related to command and control. As described above under Development of Interview Protocol, project staff increased the structure of the interviews to support conducting group interviews. Most interviews were conducted in a group format. Exceptions were officers at corps, COSCOM commander, division commanders, and division chiefs of staff. As described earlier, each commander rated the impact of each factor on the difficulty (or ease) of command and control for the mission he chose. Most of each session was devoted to discussing the rationale for those ratings.

## RESULTS

The principal results are the set of comments about the relation between each factor and the difficulty (or ease) of command and control for the particular missions chosen as points of reference by the commanders who were interviewed. These comments have been summarized in two reports under this project: Methods and Results of Data Collection on Span of Effective Command and Control (Ford & Mullen, 1994), which presents the comments by interview and includes diagrams of the organizational structure for the force projection and OOTW missions; and New Research on Span of Command and Control: Implications for Designing Army Organizations (Ford, Mullen, & Christ, in preparation), which groups the comments by factor and presents the results of a detailed content analysis. The comments have also been compiled into a relational database in the FoxPro format. The database has been installed at the Force Design Directorate, Fort Leavenworth, KS and at ARI at Fort Leavenworth, KS<sup>1</sup>.

Members of the project staff have consolidated the comments into observations that pertain to organizing and training military units. In addition to summarizing the comments, project staff summarized the factor ratings for the warfighting operations. This section presents the results of these summaries:

- Comments related to JTFs in force projection and OOTW missions.
- Ratings of the impact of factors on command and control.

---

<sup>1</sup>Copies of the database can be obtained through Dr. Richard E. Christ, ARI, Alexandria, VA.

- Comments related to Army units in warfighting operations.

### Comments Related to JTFs in Force Projection and OOTW Missions

As noted earlier, most of the comments in the force projection and OOTW interviews related to considerations in forming JTFs. Project staff derived a series of 16 recommendations based on the comments. These recommendations apply to five of the seven factors. Table 5 presents the recommendations grouped by factor, along with a representative comment that supported the observation.

Table 5

#### Overview of Recommendations on Forming JTFs from Interviews on Force Projection and OOTW Missions

Recommendation (by project staff)	Representative comment (by commander)
<b>Task Characteristics</b>	
Maintain emphasis on warfighting missions to prepare companies and platoons for OOTW.	Address rules of engagement and civilian/military matters in professional development, keeping prime focus on warfighting missions. (RESTORE HOPE)
Develop leader training related to OOTW missions for battalion commanders and higher.	Army or FEMA should conduct annual training [for predesignated augmentation officers], using the BCTP model, on natural disasters. (PROVIDE RELIEF)
<b>Organizational Structure</b>	
Base JTF HQ on a current Department of Defense (DOD) organization.	Base JTF on 3-star HQ (e.g., Army corps). (RESTORE HOPE)
Augment base with predesignated cell.	Augmentation package should be identified for each type of operation, and the operations should be professional trained. (JUST CAUSE)
Provide robust staff early, then adjust.	High early demands for emergency services coincided with the greatest turbulence in building the staff. (PROVIDE RELIEF)
Increase number of civil-military operations officers.	Extensive requirement for brigade and battalion S5s <sup>a</sup> . (RESTORE HOPE)
Structure JTF so Special Operations Force (SOF) reports to JTF commander (vice Commander in Chief [CINC]).	Having Special Forces under the control of the JTF was a good decision. (JUST CAUSE)

<sup>a</sup>Civil-Military Operations Officer on staff of battalion or brigade.

Table 5 (continued)

Recommendation (By Project Staff)	Representative Comment (By Commander)
<b>Organizational Structure (continued)</b>	
Establish and maintain clear chain of command relationships.	Command and control was complicated by difference between formal and actual chains. (SINA)
<b>Complexity of Environment</b>	
Resource and structure units to compensate for size of area of operation (AO).	Division employed as ARFOR requires augmentation of communications; doubled size of the Signal Battalion. (RESTORE HOPE)
Anticipate "mission creep."	Sources of "mission creep" in PROVIDE RELIEF: - Fill leadership vacuums among agencies. - Scope of need beyond resources for non-government organization: DOD assumed Housing Emergency Services Function from Red Cross.
Improve human intelligence information (HUMINT) capability.	Initial stages of operation hindered by "strong but wrong" intelligence information. This is a persistent problem with intelligence operations in low intensity conflict where units need to tailor operation based on HUMINT. Military services are "intelligence challenged" in OOTW. (RESTORE HOPE)
<b>Individual Characteristics</b>	
Issue clear intent and guidance.	Ambiguity for subordinates was reduced by emphasis on a clear commander's intent. (JUST CAUSE)
Establish end-states early.	Commander emphasized end-states for disengagement from the beginning -- e.g., "tents down, trailers up." (PROVIDE RELIEF)
Fill key staff positions with experienced officers.	Experienced Chief of Staff was essential--able to organize quickly and understood joint operations and how civilians were involved. (PROVIDE RELIEF)

Table 5 (continued)

Recommendation (By Project Staff)	Representative Comment (By Commander)
<b>External Organizations</b>	
Coordinate across Services to maximize capabilities.	Services brought unique capabilities: Air Force for Tactical Airlift Control; Navy "could repair anything." Mix of Services created a dynamic that enhanced professionalism. (PROVIDE RELIEF)
Incorporate volunteer and non-government agencies.	Organized help which could be focused (e.g., Mennonites) reduced burden on JTF, but only military could have handled magnitude of the disaster. (PROVIDE RELIEF)

Ratings of the Impact of Factors on Command and Control in Warfighting Operations

As described earlier, officers rated the impact of each factor on command and control in the mission. To facilitate analysis of the results, values were assigned to each rating:

Much Easier	+3
Somewhat Easier	+2
Slightly Easier	+1
No Impact	0
Slightly Harder	-1
Somewhat Harder	-2
Much Harder	-3

The mean rating of each factor across echelons is shown in Table 6. Here, and in the next two tables, the factors are listed in the order of their mean overall rated impact on span of effective command and control. The pattern of rated impact is consistent with expectations for the Wenzel-Christ factors: Technology, Individual Characteristics, and Unit Continuity tend to make command and control easier; Complexity of Environment makes command and control more difficult; and Organizational Structure, Task Characteristics, and External Organizations do not have a consistent effect. The most surprising result is the weak positive impact of Organizational Structure, which is the classical driver of the span of effective command and control.

Table 6

Mean Overall Impact of Factors

Factor	Impact
Unit Continuity	1.88
Individual Characteristics	1.68
Technology	1.27
Organizational Structure	.83
Task Characteristics	-.27
External Organizations	-.51
Complexity of Environment	-1.68

The ratings by echelon given in Table 7 show that the low impact for Organizational Structure was noted largely at the battalion echelon. Besides receiving less benefit from the structure than other officers, battalion commanders report high negative impact for Complexity of Environment and task characteristics. These findings probably reflect restricted experience among subordinate commanders and staff to help deal with ambiguities in the environment coupled with lack of time to plan and prepare operations at the battalion level.

Table 7

Mean Impact Rating by Echelon

Factor	Division N=10	Brigade N=14	Battalion N=9	Company N=8
Unit Continuity	1.90	1.79	1.89	2.00
Individual Characteristics	1.80	2.00	1.56	1.13
Technology	1.50	1.14	1.44	1.00
Organizational Structure	1.20	1.00	.11	.88
Task Characteristics	1.40	-.79	-1.00	-.63
External Organizations	-.40	-.71	-.67	-.13
Complexity of Environment	-.90	-1.79	-2.67	-1.38

The impact ratings identify Combat Service Support (CSS) units as especially sensitive to negative influences on command and control. Table 8 shows the ratings for commanders and staff of CSS, Combat Support (CS) (in this sample, only field artillery), and combat (CBT) units. The CSS commanders report the most severe negative impact of Task Characteristics and

**Complexity of Environment.** The CSS commanders indicated they received no benefit from Organizational Structure, rating their current structure as having a slightly negative impact. Comments on Organizational Structure by CSS commanders introduced number of units supported as an element of the Organizational Structure factor that frequently had a negative impact.

Table 8

Mean Impact Rating by Unit Type, Across Echelons

Factor	CSS N=10	CS N=9	CBT N=22
Unit Continuity	1.70	2.22	1.82
Individual Characteristics	1.20	1.67	1.91
Technology	1.10	1.11	1.41
Organizational Structure	-.50	1.67	1.09
Task Characteristics	-1.20	-.77	.36
External Organizations	-.50	-.22	-.64
Complexity of Environment	-2.20	-1.78	-1.41

Comments Related to Army Units in Warfighting Operations

The main emphasis in the interview sessions was to discuss the rationale for the ratings. Project staff derived a set of conclusions from the comments made in the discussions. Table 9 presents the conclusions, grouped by factor related to command and control, along with findings that supported the conclusion.

Table 9

Overview of Conclusions Related to Impact of Factors on Warfighting Operations

Conclusion	Supporting findings
<b>Task Characteristics</b>	
METL-based training on required tasks made command and control easier.	More than 75 percent of officers at division (7 of 9) reported that subordinate units knew the tasks because they were fundamental and were covered during training.
The requirement for coordination with other units increased the difficulty of command and control.	Most officers at brigade, battalion, and company (17 of 29) commented that their own tasks were more difficult than they had anticipated despite their being prepared during their training.  Combat Training Centers (CTCs) effectively replicated complexity of synchronization.
<b>Organizational Structure</b>	
Current organizational structure in terms of the number of units controlled <u>and</u> supported during combined arms operations were close to the limits of effectiveness for CSS commanders.	COSCOM: Very large span of command and control hindered effectiveness--12 battalions with 59 company equivalents.  DISCOM (3 commanders): Span of command and control (7 units) was not a problem; but span of support hindered effectiveness.  FSB (2 of 3 commanders): Spans of command and control hindered effectiveness (each responsible for 12 units).  Support companies (3 of 3 commanders): - Medical--5 platoons and evacuation responsibility for other units in AO made command and control harder. - Maintenance (2 commanders)--Number of units hindered command and control [7 sections (14 elements) in 4 platoons].

Table 9 (continued)

Conclusion	Supporting findings
<b>Organizational Structure (continued)</b>	
Current organizational structure in terms of the number of subordinate units was appropriate for Combat Support and Combat commanders.	<p>5 brigade commanders were interviewed. Their spans of command and control ranged from 6-11 subordinate units. Only 1 commander (with 9 subordinate units) cited number of units as a hindrance.</p> <p>None of the 3 DIVARTY or 3 FA battalion commanders reported problems with number of subordinate units. (DIVARTY: 6, 7, &amp; 8 subordinate units; FA Bns: 5 subordinate units.)</p> <p>1 of 3 TF commanders reported slight hindrance with 9 subordinate units; the other 2 reported no problem with their 8 and 9 subordinate units.</p>
Habitual task organization eased command and control.	<p>5 comments cited benefits of having experience working with individual commanders.</p> <p>5 comments cited the lack of habitual relationship as a hindrance to command and control:</p> <ul style="list-style-type: none"> <li>- Uncertainty about when responsibility for attached units would begin (2 citations).</li> <li>- Lack of clarity about the relation (controlled or attached) of the brigade to corps (1 citation).</li> <li>- Attached units' unfamiliarity with unit procedures (2 citations).</li> </ul>
<b>Complexity of Environment</b>	
Difficult terrain decreased span of effective command and control.	<p>Division (4 citations): BCTP allowed easy, frequent face-to-face contact for coordination and other interactions; eased direct personal contact between the commander and his subordinates.</p> <p>Large area of operations (AO) hindered command and control (3 citations):</p> <ul style="list-style-type: none"> <li>- Reduced face-to-face contact (2 citations).</li> <li>- Combination of distance and inadequate range of radios reduced quality of intelligence information.</li> </ul> <p>Command and control was hindered by heat and restrictions on movement (9 citations).</p>

Table 9 (continued)

Conclusion	Supporting findings
<b>Complexity of Environment (continued)</b>	
Ambiguities about the situation due to inaccurate or incomplete intelligence information increased difficulty of command and control.	<p>Most battalion officers (7 of 9) cited inadequate intelligence information, especially terrain analysis (4 citations).</p> <p>Most company commanders (4 of 6) were hampered by inadequate intelligence information:</p> <ul style="list-style-type: none"> <li>- Lacked information on location of units and obstacles (2 citations).</li> <li>- Lacked information on the terrain (2 citations).</li> </ul>
Ambiguities about operational procedures increased difficulty of command and control.	<p>Uncertainty about operational procedures hindered command and control:</p> <ul style="list-style-type: none"> <li>- Role of higher commands (1 citation from division).</li> <li>- Supply procedures (3 citations from brigade, 1 from company).</li> <li>- Rules of engagement (2 citations each from brigade and battalion).</li> <li>- Lack of knowledge about friendly units in the AO (1 each from brigade and company).</li> </ul>
<b>Unit Continuity</b>	
Commanders' experience with their subordinates and staff eased command and control.	<p>Of the 19 commanders who commented on experience between the commander and subordinates and staff, 15 cited such experience as a positive factor in their ability to command and control. The comments reflect a consistent, but not always successful (4 negative comments), effort to avoid ad hoc structures.</p>
An established Standard Operating Procedure (SOP) eased command and control.	<p>Fifteen officers, across echelons, rated stability of their SOP as making command and control easier. One commander of FSB had recently converted from maintenance battalion and reported that the lack of a stable SOP made command and control harder.</p>

Table 9 (continued)

Conclusion	Supporting findings
<b>Technology</b>	
Availability of technology made command and control easier at division level and within the Airborne Division, but results are mixed for lower echelon units.	<p>Division officers positive on MCS<sup>a</sup>, MSE<sup>b</sup>/SINCGARS<sup>c</sup>, and ASAS<sup>d</sup>; brigade positive on MSE/SINCGARS but negative on MCS and ASAS; battalion negative on MCS and divided on MSE/SINCGARS; company divided on MSE/SINCGARS.</p> <p>Officers in the Airborne Division perceived Technology as more helpful than did officers in heavy divisions.</p>
Technology imposed hidden costs, especially at lower echelons.	<p>Characteristics that detracted from benefits of technology:</p> <ul style="list-style-type: none"> <li>- Some systems not integrated (1 comment—CSS not tied to MCS).</li> <li>- Requirements for additional space and personnel to store, operate, and maintain equipment; to enter and process information (2 citations).</li> <li>- Requirements for additional generators and resulting increased vulnerability to detection (1 comment).</li> <li>- Loss of customary residual benefits (1 comment—cannot “eavesdrop” on other units’ nets on MSE).</li> </ul>
<b>Individual Characteristics</b>	
Skilled subordinate commanders facilitated command and control.	<p>At levels above company, 18 officers said that the high quality of subordinate commanders made command and control easier; 3 said that the low quality hindered.</p> <p>No company commander reported being aided by platoon leaders (PLs); 3 cited low skill of their PLs as making command and control more difficult.</p>

<sup>a</sup> Maneuver Control System

<sup>b</sup> Mobile Subscriber Equipment

<sup>c</sup> Single Channel Ground Airborne Radio System

<sup>d</sup> All-Source Analysis System

Table 9 (continued)

Conclusion	Supporting findings
<b>Individual Characteristics (continued)</b>	
<p>A skilled, experienced staff eased command and control at division and brigade.</p>	<p>Division officers (6 citations) were positive about skill and experience of staff (especially that of Chief of Staff) in the Division Main (DMAIN) command post as aids in command and control; 2 officers cited depth of personnel staffing in the DMAIN as factor that hindered command and control.</p> <p>Two officers (from different divisions) cited lack of skill and experience in the Division Rear as making command and control more difficult.</p> <p>All (3) brigade comments were positive: Staff made command and control easier.</p> <p>Mixed impact on command and control at battalion:</p> <ul style="list-style-type: none"> <li>- Helped by technical proficiency of staff (2 citations).</li> <li>- Hindered by turbulence among staff (3 citations).</li> <li>- Mixed (2 citations), e.g., Staff members had limited experience but were technically competent.</li> </ul>
<p>Technically competent Non-Commissioned Officers (NCOs) eased command and control.</p>	<p>Battle Staff NCO Course cited (3 citations) as making command and control easier (“allowed officers to be battle captains”).</p> <p>NCOs at troop levels:</p> <ul style="list-style-type: none"> <li>- Skill and independence of NCOs eased command and control at company (3 citations).</li> <li>- Training of Logistics NCOs inadequate for their role as replacements when Logistics Officers participate in planning at higher HQ (1 citation).</li> </ul>

Table 9 (continued)

Conclusion	Supporting findings
<b>External Organizations</b>	
With quality liaison, U.S. military elements outside the unit's organization added valuable capability.	Benefits of air support, air defense, and information from special operations forces was contingent on the experience and ability of liaison officers (LNO): - 3 units had effective LNOs, who eased command and control. - 1 unit had ineffective LNO, lost benefits of air defense assets and complicated land management.
Authorizing and training subordinates in coordinating with civilians would increase the span of effective command and control.	Coordination with civilians imposed demands on a commander's time and attention (3 citations), largely because coordination could not be delegated.

## GENERAL DISCUSSION

The database of performance incidents from this project was intended to be a start point for future data collections. This section recommends modifications of the data collection procedure and proposes further applications of the approach.

### Modifications to Procedure

Experience in collecting the data summarized above confirms that the factors related to command and control (Table 1) are comprehensive and pertinent to military operations. Those factors should continue to be the basis for structuring surveys and interviews and for summarizing the results. Of the two protocols applied in this project, the structured interview on factors is recommended for future work. It is more efficient in focusing the discussion, and thus requires less time of the interviewee. The group interviews generated valuable additional discussion as well as saving time.

The interview technique, however, should be modified for future data collections. The main modification would be to give closer attention to diagrams of the organization by probing for the nature and frequency of contact with subordinate elements. This modification will require reducing the size of the groups for the group interviews to a maximum of three (the battalion and company interviews in this study were conducted with groups of six). Such a reduction, by itself, would be beneficial. The group interviews at the brigade and higher echelons (with groups of three) were productive, creating a valuable dynamic among the officers. The battalion and company groups were less productive; the size and diversity (lieutenant colonels and captains) of the groups probably contributed to the reduced productivity.

## Further Applications of Procedure

Increase the database. The 55 officers who were interviewed (11 on force projection and OOTW and 44 on warfighting operations) provided insightful and candid comments that form the framework for a database on command and control. While the comments provide clues to consider for organizing and training units, the current sample is too small for definitive conclusions. For the database to be a sufficient basis for such conclusions, it should be augmented both for force projection/OOTW and for warfighting operations.

Add other echelons to the force projection and OOTW database. The current database for force projection and OOTW missions includes very little information below division: i.e., one brigade commander, one battalion commander, and no company commanders. Information from lower echelons, especially on the impact of ambiguity and the levels of rules of engagement, would be valuable. The database should also be augmented by information on CSS officers in OOTW missions--issues to address include complications imposed by large areas of operations, coordinating with host nation support, and modifications required to support joint forces.

Develop support materials for OOTW. As data are added, it would be possible to provide guidance (if not training) on effective techniques and procedures from relevant operations to officers assigned or about to be assigned to an OOTW. In such an application, the command and control insights would be included along with information specific to the new operation. The additional information should address subjects such as climate, culture, religion, possible threats, geography, private and non-government organizations, and specific rules of engagement. The current database structure would be compatible with a lap top computer.

Expand database on warfighting operations with CTC experience. The database should be expanded at all echelons following rotations to the CTCs. Such interviews at NTC, JRTC, and Combat Maneuver Training Center (CMTC) should be conducted at least once a year. One benefit of this expansion of the database will be to monitor the impact of the introduction of new equipment. It would be especially valuable to conduct interviews after Corps exercises in BCTP, since the database currently includes only one officer in each of the following positions: Corps Commander, Deputy Commanding General, Chief of Staff, and COSCOM Commander. Of course, each BCTP rotation gives an opportunity to expand the information at the Division echelon.

Develop a database on the Experimental Force. The span of command and control factors and the data collection procedures described in this report would be useful for focusing observations and interviews with the Experimental Force (EXFOR) at Fort Hood, Texas. The EXFOR provides an opportunity to evaluate directly the impact of high technology systems and innovative force design concepts, both of which are being incorporated into the EXFOR. Special attention should be paid to the impact of these factors on both span of command and control and the span of support. It would also be important to monitor the impact of technology and organizational design on command, control, and support relationships at each echelon of the EXFOR. These new incidents and observations occurring with the EXFOR would be very valuable additions to the database.

## CONCLUSIONS

The experience gained by collecting and consolidating data to meet the objectives of this project has confirmed that the factors suggested by Wenzel and Christ (1993) are suitable for collecting observations through interviews on command and control in training and operational environments. The database organized on the factors is an efficient mode to deliver results on the observations.

Any guidelines for designing units must necessarily be expressed cautiously because of the limited sample. Despite the limited sample size, the findings are consistent with theory and practical experience.

The most consistent finding for force projection and OOTW missions stressed the importance of avoiding *ad hoc* structures. To do that, a JTF should be built on an existing DOD unit, augmented as necessary by a specially trained cell.

A persistent issue among officers interviewed on Force Projection and OOTW was whether training should be designed specifically for OOTW. Officers in this sample were consistent in the opinion that training for OOTW missions should consist primarily of leader training at brigade and higher levels (covering subjects such as Emergency Services Functions in domestic emergencies). Training at lower echelons should continue to focus on warfighting operations. The discipline, team building, and familiarization with the chain of command resulting from that training will strengthen small-unit capability on all types of missions.

The interview results on warfighting operations found that commanders and staff at corps, division, and brigade levels and most company commanders were able to cope with the complexity of the combat environment with their current organizational structure. Battalion commanders reported more severe negative impact from the complexity of the environment and less assistance from their organizational structure.

The central question for the project concerned whether the number of subordinate units at each echelon was appropriate. No officer in interviews on force projection or OOTW missions cited the number of subordinate units as a problem. Commanders of CSS units were the only officers in the warfighting sample to comment consistently that the span of command and control was too large. CSS commanders also cited span of support (especially at DISCOM and company levels). Lack of habitual relationship with supported units seemed to have at least as much negative impact as the number of subordinate units.

## REFERENCES

Department of the Army (June, 1993). Operations (FM 100-5). Washington DC.

Flanagan, J. C. (1954). The critical incident technique. Psychological Bulletin, 51, 327-258.

Ford, P., & Mullen, W. J., III (1994). Methods and results of data collection on span of effective command and control. Presidio of Monterey, CA: BDM.

Ford, P., Mullen, W. J., III, & Christ, R. E. (in preparation). New research on span of command and control: Implications for designing organizations (ARI Research Note). Alexandria, VA: U.S. Army Research Institute for the Social and Behavioral Sciences.

Klein, G. A., Calderwood, R., & MacGregor, D. (1989). Critical decision making for eliciting knowledge. IEEE Transactions on Systems, Man, and Cybernetics, 19, 462-472.

Koontz, H., O'Donnell, & Weihrich, H. (1984). Management. New York: McGraw-Hill.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Mintzberg, H. (1983). Structure in fives: designing effective organizations. Englewood Cliffs, NJ: Prentice-Hall.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing I: Detection, search, and attention. Psychological Review, 84, 1-66.

Wenzel, B. M., & Christ, R. E. (1993). The resurrection of span of control. Proceedings of the 37th Annual Meeting of the Human Factors and Ergonomics Society. Santa Monica, CA: Human Factors and Ergonomics Society.

Wickens, C. D. (1980). The structure of attentional resources. In R. Nickerson (Ed.), Attention and performance VIII (pp. 239-257). Hillsdale, NJ: Laurence Erlbaum.